MASTER OF SCIENCE
IN
ELECTRICAL ENGINEERING

**ANALYSIS OF TACTICAL EXFILTRATION AND DISSEMINATION OF UNATTENDED
GROUND SENSOR DATA USING NATIONAL SYSTEMS**
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This thesis develops technical design inputs and mission effectiveness analyses in support of the design process for a conceptual signals intelligence payload. The report summarizes the operating characteristics of unattended ground sensors currently fielded or in development and Low Probability of Intercept/Low Probability of Detection (LPI/LPD) waveforms used in exfiltrating the data they generate. An objective payload comprising a software-defined radio frequency front end and a generic, reprogrammable, multi-threaded processor is proposed, which would have the capability to receive, despread, demodulate, and downlink the sensor data to the tactical user. Theoretical bit error performance of an LPI/LPD data exfiltration waveform is estimated. Communications link and system level performance are subsequently modeled for a variety of host platforms to enable examination of the design trade space for the proposed payload. Conclusions are drawn from this examination as to the effectiveness and suitability of the objective payload for both facilities monitoring and time critical targeting type missions.

KEYWORDS: Unattended Ground Sensors, Special Communications, Special Reconnaissance, Time Critical Targeting

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**PERFORMANCE ANALYSIS OF OFDM IN FREQUENCY-SELECTIVE,
SLOWLY FADING NAKAGAMI CHANNELS**
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In an effort to offer faster, more reliable wireless communications services to the public, many wireless standardization committees have, in recent years, adopted Orthogonal Frequency Division Multiplexing (OFDM) as the modulation technique of choice. Given the incredible growth in the industry as manifest by the seemingly infinite demand for wireless products and services and the accompanying need for superior performance of these systems in congested and electronically demanding environments, it is evident that OFDM will be at the core of many future high data rate communications systems. This thesis examines the performance of OFDM in frequency-selective slowly fading Nakagami channels. The Nakagami channel is used in this study as it probably best models the propagation characteristics of the environments in which OFDM based systems will be applied.

KEYWORDS: OFDM, Nakagami, Modulation, Multiplexing, Frequency-Selective, PSK, QAM, Multipath Fading, FEC Coding, Hard-Decision Decoding, Soft-Decision Decoding

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ELECTRICAL ENGINEERING

FFT-BASED SPECTRUM ANALYSIS USING A DIGITAL SIGNAL PROCESSOR
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A spectrum analyzer based on Fast Fourier Transform (FFT) techniques was implemented using the TMS320C6201 Digital Signal Processor device manufactured by Texas Instruments. Portable C programs demonstrated optimization of the FFT algorithm for maximum speed on a general-purpose processor. Previously published algorithms were then adapted to the unique features of this Very-Long Instruction Word (VLIW) parallel processor and the performance requirements of this application, taking into account fixed-point arithmetic, parallel operation of functional units, and a hierarchy of memory capacities and speeds. The effectiveness of the VLIW C compiler, with automatic optimization, is compared with an explicitly-scheduled assembly-language program. The resulting program was then used to demonstrate the crucial need to keep program data in the Internal Data Memory to preserve hard-won performance gains.

KEYWORDS: Fast Fourier Transform, Digital Signal Processing, Very Long Instruction Word, Cache Memory

RADIATION EFFECTS ON MULTI-JUNCTION SOLAR CELLS
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The $GaInP_2$/GaAs/Ge monolithic high efficiency triple junction cell is the state of the art multi-junction solar cell for space applications. Numerous labs have undertaken investigation into the stability of GaInP2/GaAs/Ge in response to electron radiation. Electron radiation experiments have shown that the degradation of $GaInP_2$/GaAs/Ge solar cells is mainly caused by a decrease of the short circuit current (I_{SC}). The investigation and interpretation of the damage mechanism from electron irradiation in Spectrolab's $GaInP_2$/GaAs/Ge triple junction cell is the purpose of this thesis. Current voltage characteristics were measured to establish beginning of life (BOL) parameters of the solar cells and the changes that occur due to irradiation (EOL).

KEYWORDS: Solar Cell, Multi-junction Solar Cells, GaInP2/GaAs/Ge, Radiation Effects

ACTIVE QUEUE MANAGEMENT MECHANISMS
FOR REAL-TIME TRAFFIC IN MANETS
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This thesis develops active queue management mechanisms for real-time traffic for MANETs. Providing QoS for real-time applications is still an open issue as stated in RFC 2309. The proposed packet-dropping algorithm called Selective Early Discard (SED) selectively drops packets in order to spread the packet losses in a queue. Two variations of SED are also examined: one adds priority in order to provide service differentiation and the other utilizes timestamps to enable the intermediate nodes to drop packets that are likely to be unusable by the receiver due to excessive delay. Another scheme that drops bits instead of packets is also investigated.

Using simulation, the new queuing schemes are evaluated in a MANET environment, and their performance is compared with other existing QoS schemes, such as Random Early Discard (RED) and First In First Out (FIFO). Results indicate that SED minimizes the burst errors due to buffer overflow, thereby improving the performance for real-time traffic. SED is also capable of providing service differentiation; additional performance improvement can be realized by utilizing timestamps. Bit-dropping techniques can provide further performance improvements by spreading the error at the bit level (versus spreading the error at the packet level as in SED).

KEYWORDS: Joint Tactical Radio System, Network Simulator 2, Dynamic Source Routing, Quality of Service, Differentiated Services, Mobile Ad-Hoc Network, Real-Time Traffic, Packet Dropping, Bit Dropping, Voice Over IP

EXTENDING IEEE 802.11b WIRELESS LOCAL AREA NETWORKS TO THE METROPOLITAN AREA
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The IEEE 802.11b wireless local area networking (WLAN) protocol does not specify a maximum permissible range limitation. Rather, the protocol permits network data rates to vary based on the instantaneous link conditions present. This thesis analyzes the impact of distance on perceived network link quality for IEEE 802.11b WLAN systems. An experimental IEEE 802.11b wireless network testbed is developed and deployed within a metropolitan area (1–40 kilometers) for the quantitative analysis of link quality for various realistic types of network traffic. Additionally, the functional limitations of individual system components are identified for consideration in the planning of future experiments.

KEYWORDS: CCK Modulation, Multipath Fading, Wireless LAN (WLAN), IEEE 802.11, Carrier Sense Multiple Access With Collision Avoidance, CSMA/CA, Direct Sequence Spread Spectrum, DSSS, Medium Access Control, MAC Layer, Cost-Effective Access, Information Infrastructure

ATTITUDE DETERMINATION USING STAR TRACKER DATA WITH KALMAN FILTERS
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This study adapts some established attitude determination techniques for use with star tracker measurements on satellites. Other work in this area has utilized gyro measurements with star tracker updates. Today's star trackers are giving measurements with accuracies of less than 6 arcseconds, and are therefore of high enough fidelity to be used alone. Computer simulation of a Linear Kalman Filter to process these measurements is presented. The filter uses a linear, constant coefficient state matrix with the Optimal Control Law to provide negative feedback control. The control law uses information developed through the equations of motion of the spacecraft in a Molnyia orbit. Modifications to the filter, including glitch rejection and various covariance manipulation techniques are discussed as possible sources for performance enhancement.

KEYWORDS: Attitude Determination, Kalman Filter, Linearized Spacecraft Dynamics